(12) UK Patent Application (19) GB (11) 2 195 022 (13) A

(43) Application published 23 Mar 1988

(21) Application No 8621613

(22) Date of filing 8 Sep 1986

(51) INT CL[4]
G01N 29/04

(52) Domestic classification (Edition J):
G1G 9X EEM

(56) Documents cited
GB 1203854

(58) Field of search
G1G
Selected US specifications from IPC sub-class G01N

(71) Applicant
United Kingdom Atomic Energy Authority

(Incorporated in United Kingdom)

11 Charles II Street, London SW1Y 4QP

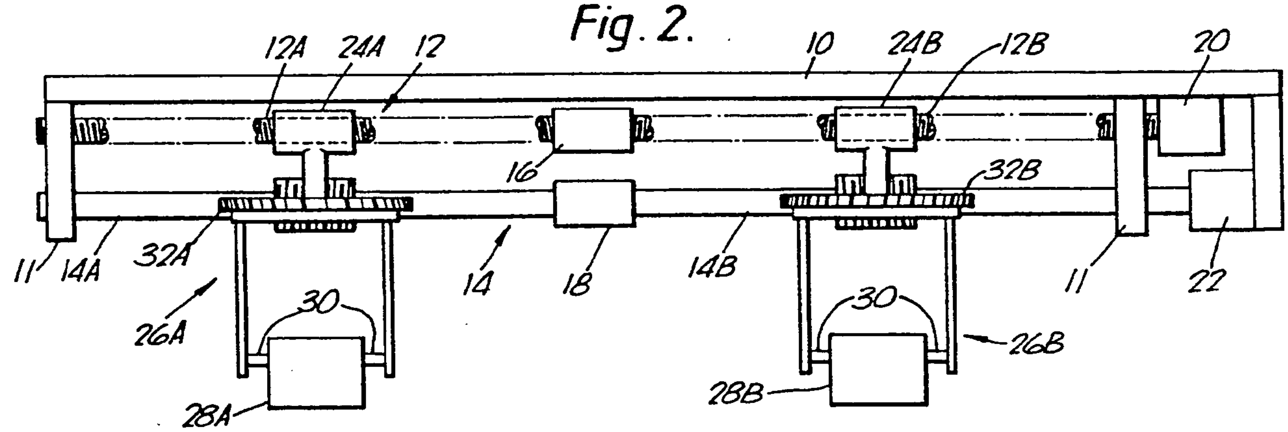
(72) Inventors
Allan Rogerson
Paul Julian Highmore

(74) Agent and/or Address for Service
A R Collingwood,
Patents Branch, United Kingdom Atomic Energy Authority, 11 Charles II Street, London SW1Y 4QP

(54) **Ultrasonic scanning apparatus**

(57) Ultrasonic scanning apparatus for use in time of flight diffraction and tandem techniques comprises a carrier (10) on which are mounted a pair of transducers (26A, 26B). Drive arrangements (12, 16, 20; 14, 18, 22) are provided for displacing the transducers both rotatably and translationally to permit various modes of scanning. Clutch 16 allows for relative linear displacement of both transducers or displacement of one only. Clutch 18 allows for contra-rotation of both transducers or rotation of one only.
Application is to inspection of flows in specimens or vessel fabrications.

Fig. 2.



GB 2 195 022 A

-8 SEP.86- 21613

D F A

2195022

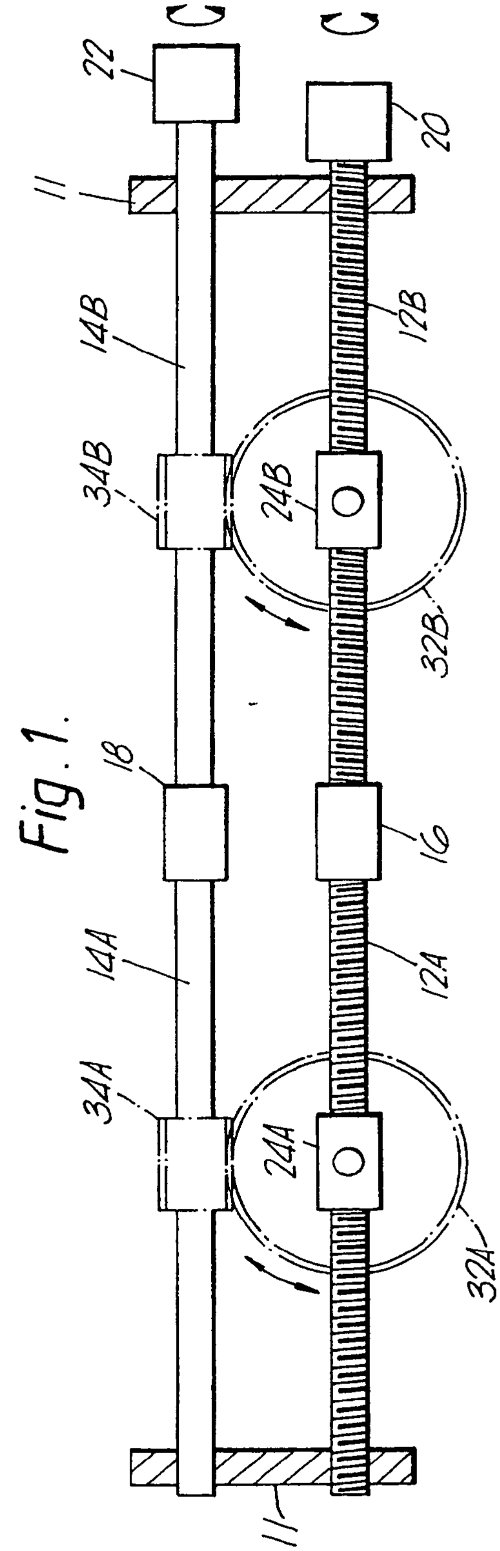


Fig. 1.

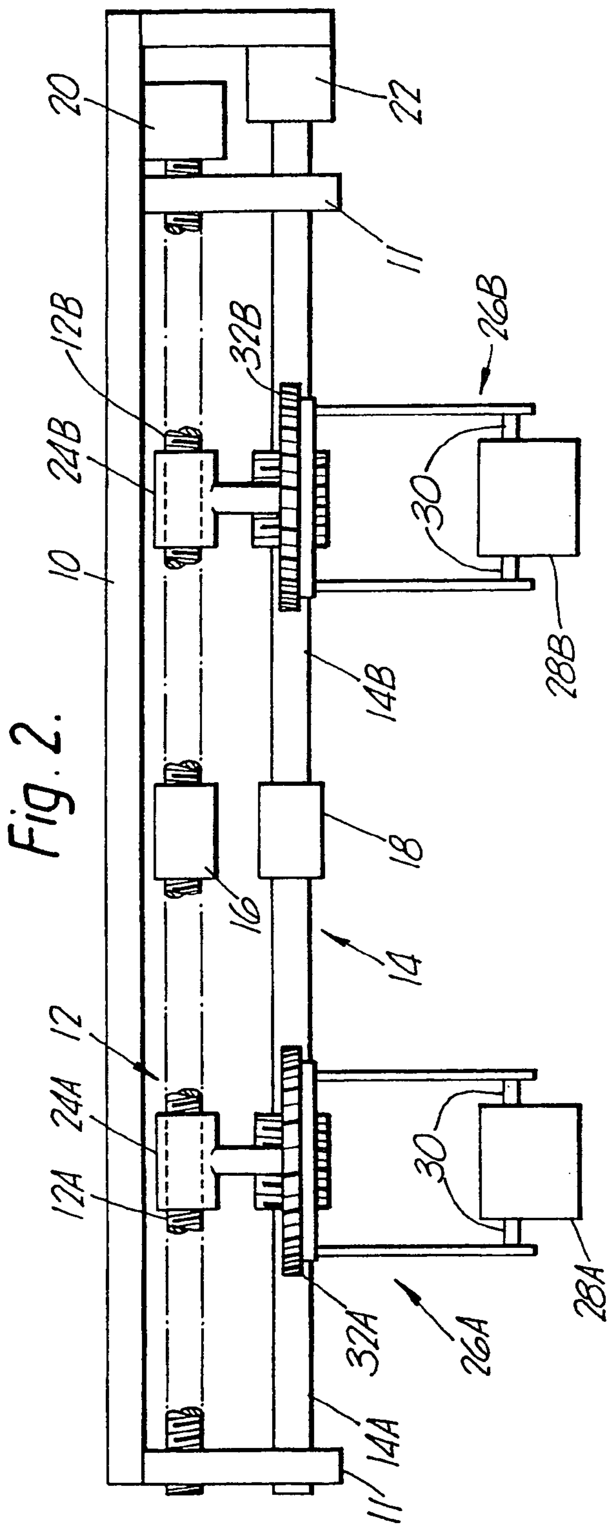


Fig. 2.

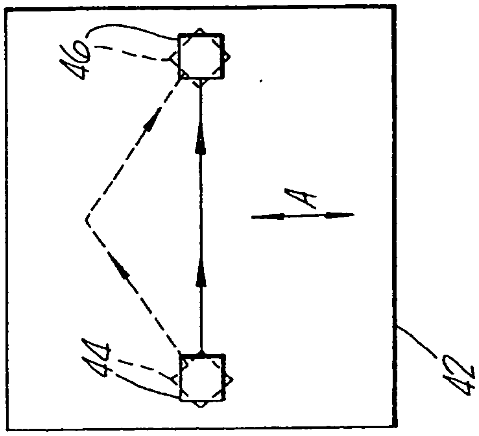


Fig.5.

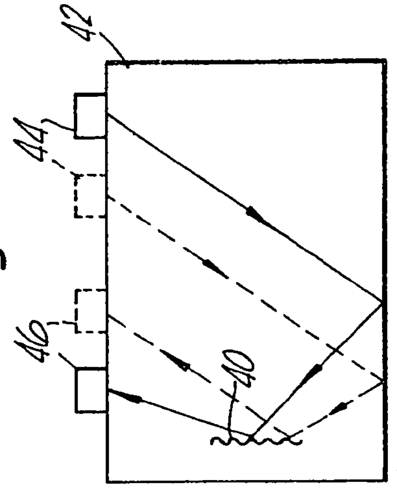


Fig.8.

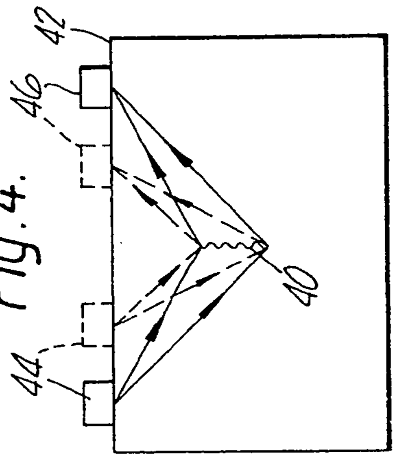


Fig.4.

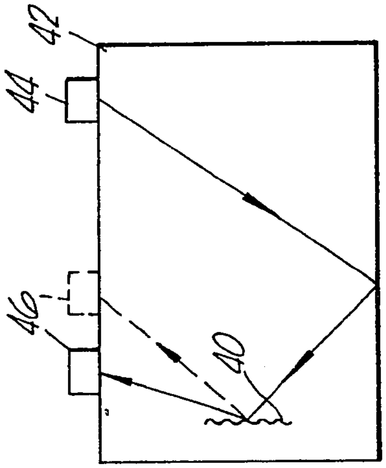


Fig.7.

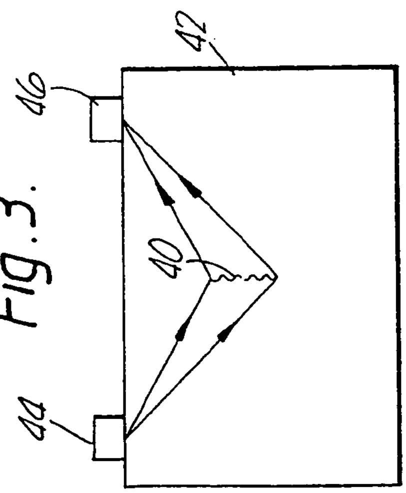


Fig.3.

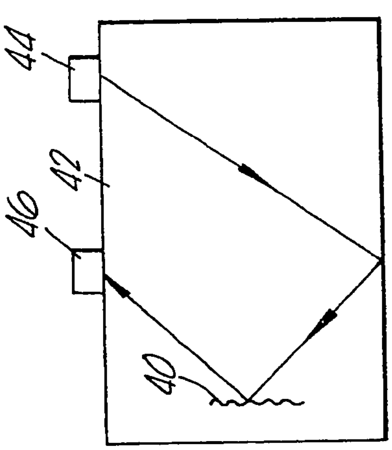


Fig.6.

SPECIFICATION

Ultrasonic scanning apparatus

This invention relates to ultrasonic scanning apparatus for use in the inspection of flaws in specimens and especially vessel fabrications.

The invention is particularly concerned with apparatus for use in time of flight deffraction (TOFD) and tandem (or pitch and catch) techniques of ultrasonic inspection.

According to the present invention there is provided ultrasonic scanning apparatus comprising a transmitting transducer, a receiving transducer, a carrier mounting the transducers, first drive means for effecting relative movement between the transducers so as to vary the separation between them and second drive means for effecting rotation of the transducers about axes generally perpendicular to the direction of movement effected by the first drive means.

Apparatus as defined above affords greater versatility in the scanning modes possible using the TOFD and tandem techniques, as will become apparent from the following description with reference to the accompanying drawings illustrating, by way of example only, one embodiment of the invention.

In the drawings:

Figure 1 is a schematic plan view of the scanning apparatus;

Figure 2 is a side view of the apparatus;

Figures 3–5 illustrate schematically various scanning modes using the TOFD technique; and

Figures 6–8 illustrate different scanning modes that can be used using the tandem technique.

Referring to Figs. 1 and 2, the apparatus comprises a carrier frame 10, end supports 11 of which, via unshown bearings, mount a pair of generally horizontal drive shaft assemblies 12, 14 which run generally parallel to one another. Each drive shaft assembly 12, 14 comprises two axially successive sections 12A, 12B and 14A, 14B coupled by clutch devices 16, 18 respectively. At one end, each shaft assembly 12, 14 is coupled to a respective reversible drive motor 20, 22. Although both shown mounted at the same end of the carrier, the drive motors 20, 22 may instead be mounted at opposite ends of the carrier to balance one another.

The drive shaft sections 12A, 12B are in the form of lead screws which are of opposite hand to one another and mesh with respective internally threaded sleeves 24A, 24B which are coupled to ultrasonic probe holders 26A, 26B in such a way that the probe holders are rotatable about generally vertical axes. Each probe holder 26A, 26B includes a transducer mounting 28A, 28B mounted by pivots 30, the transducers (not shown as such) being spring-loaded to bear against a surface of a specimen to be scanned. When the clutch 16 is operative and the motor 20 is energised to rotate the shaft section 12B (and hence the shaft section 12A via clutch 16), the probe holders are advanced towards or away from each other in a direction parallel to the shaft sections 12A, 12B.

The shaft assembly 14 is effective to rotate the probe holders about their generally vertical rotary axes and, for this purpose, each probe holder 26A, 26B is coupled to a respective drive shaft section 14A, 14B via a worm drive comprising worm wheel 32A, 32B, which is rotatably fast with the probe holder, and a worm gear 34A, 34B (see Fig. 1) which constantly meshes with its respective worm wheel and is slidable along its respective shaft section 14A, 14B to allow it to follow axial movement of the probe holder when motor 20 is energised. The shaft sections 14A, 14B are of non-circular section (eg square) and pass through complementary bores in the worm gears 34A, 34B to render the worm gears rotatably fast with the shaft section 14A, 14B while allowing the above-mentioned sliding movements.

It will be seen that energisation of the motor 22 with the clutch 18 engaged will cause both probe holders to rotate about the axes of the worm wheels irrespective of the axial positions of the probe holders. The toothed profiles of the worm wheels and worm gears are arranged so that the probe holders counter-rotate with respect to one another thereby enabling the beams of the transducers to be maintained in intersecting relation over wide angles of rotation of the probe holders.

The clutches 16, 18 are selectively disengageable so that, when desired, translational and/or rotational drive can be imparted to both probe holders (when the clutches are engaged) or only one of the probe holders (when the clutches are disengaged). In the latter event, one probe holder will remain stationary in terms of translation and/or rotation. In use one transducer may function as a transmitter and the other as a receiver.

Fig. 4 illustrates the standard time of flight diffraction technique for the inspection of a flaw 40 in a specimen 42. In the standard method, both the transmitter 44 and receiver 46 are fixed. The apparatus described above allows the transmitter and receiver to be moved towards and away from one another and skewed or rotated in a co-ordinated manner thus allowing additional data to be collected for use in sizing and characterisation of detected flaws. Thus, as shown for in Fig. 4, data may be collected with the transmitter and receiver located either side of the flaw 42 and at different spacings. In Fig. 5 (which is a plan view of the specimen 42 and hence it will be understood that the ultrasonic beams will have a vertical component as well as the horizontal components shown), the transmitter 44 and

receiver 46 are shown in an aligned position (solid outline) and skewed positions (broken outline). If desired, upon location of a flaw whose size and characteristics call for closer examination, the carrier frame 10 may be caused to execute a linear traverse in the direction A (see Fig. 4) such that the transmitter 44 and receiver 46 are generally equidistant from the vertical plane in which the flaw lies and in the course of the traverse, the transducers 44, 46 may be continuously rotated in a co-ordinated manner so as to remain sighted on the flaw location of interest. A number of such traverses may be made with the transducers spaced to different extents.

Fig. 6 illustrates the standard method used in the tandem technique. As shown in Fig. 7 this may be modified to derive additional data by displacing the receiver 46 towards or away from the transmitter which may remain fixed, ie by disengaging the clutch 16 – see Figs. 1 and 2 – and using the probe holder 26A as the transmitter. Fig. 8 illustrates the tandem method in which ultrasonic data is collected while both transmitter 44 and receiver 46 are moved continuously towards and away from each other, ie with clutch 16 engaged.

The carrier frame 10 may be mounted for a linear traverse as described above or, in some circumstances, it may be mounted for pivotal motion or rotation about a generally vertical axis and its axis of pivoting or rotation may be generally coincident with the centre point between the probe holders 26A, 26B.

The above description of the different scanning modes is not intended to be exhaustive. A wide variety of possibilities will be seen to be feasible and a particular scanning mode may be selected according to the nature and location of the defect.

CLAIMS

1. Ultrasonic scanning apparatus comprising a transmitting transducer, a receiving transducer, a carrier mounting the transducers, first drive means for effecting relative movement between the transducers so as to vary the separation between them and second drive means for effecting rotation of the transducers about axes generally perpendicular to the direction of movement effected by the first drive means.

2. Apparatus as claimed in Claim 1 in which the first drive means is operable to displace both transducers simultaneously.

3. Apparatus as claimed in Claim 1 in which the first drive means is selectively operable to displace both transducers simultaneously or to displace one transducer while the other transducer is maintained stationary.

4. Apparatus as claimed in Claim 1, 2 or 3 in which the first drive means comprises a drive shaft assembly comprising axially sucessive sections each having a screw-thread in [illegible] with a drive-transmitting element associated with a respective transducer, the screw-threads of said sections being arranged in opposite-handed relation.

5. Apparatus as claimed in Claim 4 comprising a common drive motor coupled to one shaft section and a clutch device for selectively coupling the second shaft section to the first shaft section whereby, with the clutch engaged, both shaft sections are driven by the motor and, with the clutch disengaged, only said first shaft section is driven by the motor.

6. Apparatus as claimed in any one of Claims 1–5 in which the second drive means is operable to effect co-ordinated contrarotation of the transducers whereby the intersection zone of the transducer beams can be swept along a plane extending between the transducers.

7. Apparatus as claimed in Claim 6 in which the second drive means is operable in a second mode in which only one of the transducers is rotated.

8. Apparatus as claimed in any one of Claims 1–7 in which the second drive means comprises a drive shaft assembly coupled with the transducers via respective pairs of drive-transmitting elements which are capable of maintaining their drive-transmitting relation while following movement of the transducers effected by the first drive means.

9. Apparatus as claimed in Claim 8 in which each pair of drive transmitting elements comprises a worm gear slidably mounted on a drive shaft of the second drive means and a worm wheel associated with the respective transducer.

10. Ultrasonic scanning apparatus substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

Published 1988 at The Patent Office, State House, 66/71 High Holborn, London WC1R 4TP. Further copies may be obtained from The Patent Office, Sales Branch, St Mary Cray, Orpington, Kent BR5 3RD. Printed by Burgess & Son (Abingdon) Ltd. Con. 1/87.